WE CLAIM:

1. A method of coating a titanium based surface to provide oxidation protection and improved fatigue properties at elevated temperatures , comprising:

applying a protective coating to the surface, the coating being applied to the surface and having an aluminum conversion layer applied at a temperature below which aluminum does not appreciably react with titanium and of a thickness of less than about 12 microns; and

heat treating the conversion layer so that the aluminum oxidizes and interacts with the titanium to form titanium aluminide.

2. The method of Claim 1 wherein said coating is applied at a thickness of between about 2 to 12 microns.

3. The method of Claim 1, wherein the aluminum conversion layer is transformed to titanium aluminide by heating at a controlled rate above about 500°C followed by a hold at a temperature no more than about 750°C, and cooling at a controlled rate back down to about 500°C.

4. The method of Claim 1, wherein the conversion layer is applied by gaseous deposition.

5. The method of Claim 4, wherein the gaseous deposition and heat-treating are performed separately.

6. The method of Claim 1, wherein the conversion layer is applied at a temperature below 450°C.

7. The method of Claim 1, wherein the conversion layer is oxidized to form an alumina surface layer.

8. A method of applying a coating to a titanium-based substrate, comprising:

applying an aluminum conversion layer of between 2 to 12 microns on the substrate by gaseous deposition, the layer being deposited at a temperature below which aluminum does not appreciably react with titanium; and

heat-treating the conversion layer so that the aluminum oxidizes to form alumina and interacts with the titanium to form the titanium aluminide.

9. The method of Claim 8, wherein the aluminum conversion layer is transformed to titanium aluminide by heating at a controlled rate above about 500°C followed by a hold at a temperature no more than about 750°C, and cooling at a controlled rate back down to about 500°C.

10. The method of Claim 8, wherein the gaseous deposition and heat-treating are performed separately.

11. The method of Claim 8, wherein the conversion layer is applied at temperatures below 450°C.

12. A method of applying a coating to a titanium-based substrate, comprising:

applying an aluminum conversion layer of between 2 to 12 microns on the substrate by gaseous deposition, the layer being deposited at a temperature below which aluminum does not appreciably react with titanium and below the melting point of Al; and

heat-treating the conversion layer so that the aluminum oxidizes to form alumina and interacts with the titanium to form the titanium aluminide, and the conversion layer is oxidized to form an alumina surface layer.

13. The method of Claim12; wherein the conversion layer is applied at a temperature below 450°C.

14. The method of Claim 12, further including the step of cleaning the titanium-based alloy surface prior to aluminum deposition.

15. The method of Claim 14, wherein said surface is cleaned with a dilute caustic solution of KOH.

16. The method of Claim 15, wherein the aluminum conversion layer is transformed to titanium aluminide by heating at a controlled rate of below 640°C after cleaning the surface.

17. A method of coating a titanium based surface to provide oxidation protection at elevated temperatures, comprising:

applying a protective coating to the surface, the coating being applied by applying an aluminum conversion layer to the surface at a temperature below which aluminum does not appreciably react with titanium and of a thickness of less than 12 microns;

heat treating the conversion layer so that the aluminum oxidizes and interacts with the titanium to form titanium aluminide; and

cleaning the titanium-based alloy surface prior to applying a protective coating.

18. The method of Claim 17, wherein said surface is cleaned with a dilute caustic solution of KOH.

19. The method of Claim 18, wherein the aluminum conversion layer is transformed to titanium aluminide by heating at a controlled rate of below 640°C after cleaning the surface.

20. An oxidation protective coating for a titanium-based alloy surface comprising:

a heat-treated aluminum conversion layer applied to the titanium-based alloy surface having a thickness of less than 12 microns.

21. The coating of Claim 20, wherein said conversion layer is transformed to titanium aluminide.

22. The coating of Claim 21, wherein said conversion layer is between 2 to 12 microns in thickness.

23. The coating of Claim 20, wherein said conversion layer is transformed to titanium alumnide during heat treatment of the titanium based alloy. immediately prior to said heat treatment

24. The coating of Claim 20 wherein said conversion layer is transformed to titanium aluminide during heat treatment of the titanium based alloy.

25. A method of applying a coating to a brazed substrate comprising:

applying an aluminum conversion layer of between 2 to 12 microns on the substrate by gaseous deposition, the layer being deposited at a temperature below which aluminum does not appreciably react with any titanium which may or may not be present in the braze; and

heat treating the conversion layer so that the aluminum oxidizes to form alumina, and if the braze contains Ti, interacts with the titanium to form titanium aluminide.